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NUMERICAL STUDY ON OPPOSED FLOW FLAME SPREAD OVER PARALLEL THIN FUEL SHEETS IN MICROGRAVITY ENVIRONMENT

Abstract

Fire safety of spacecrafts involving space missions in low gravity environments is an issue of functional significance for space research activities. The need to prevent and control fires in space-crafts has necessitated active research efforts aimed at understanding of mechanisms controlling spread of flames. In the study of flame spreading mechanisms, most of studies are carried with a single fuel sheet to understand the flame spreading mechanisms and investigate flammability of solid materials. However, in most of practical situation flame spread may involve interaction with flame from nearby burning fuel. This interaction is likely to alter the flame spreading behaviour and flammability map from that of a single fuel sheet. The efforts in present research are motivated by need to have better fire safety.

Flame spreads over surface of combustible material through heat transfer from burning region to non-burning region. This is primary condition that must be met for flame to spread. The rate at which flame propagates is directly proportional to heat available at solid fuel surface. The presence of parallel burning fuel brings additional heat transfers from interacting flame, which affects flame spread behavior. In space, where we have little or no gravity, radiation becomes dominant mode of heat transfer. The role of flame radiation interactions in spreading of flames is accounted.

A two dimensional numerical model of opposed flow flame spread has been formulated and modeled with parallel burning fuels (Kimwipes sheets with area density 0.001g/cm2). It comprises of solid phase and gas phase equations modeled to simulate parallel burning thin solid fuel sheets. The work investigates characteristics of flame interactions, the structure of spreading flames, dependence of ame spread rate on the separation distance between solids and extinction limits for different operating conditions in micro gravity environment with oxygen concentration ranging from 25

Simulations show that flame spread rate strongly depends on the separation distance between the two fuel sheets. With reduction in separation distance between burning fuels, flame spread rate increases and reaches the maximum value at a finite separation distance. Further decrease in separation distance results in reduction of flame spread rates. In present study simulations have also been carried out to obtain flame extinction in microgravity by decreasing the oxygen concentration insteps. A flammability boundary is constructed with oxygen level and distance between adjacent fuel strips. Interestingly the multiple-fuel configuration is found to be more flammable than single fuel strip.